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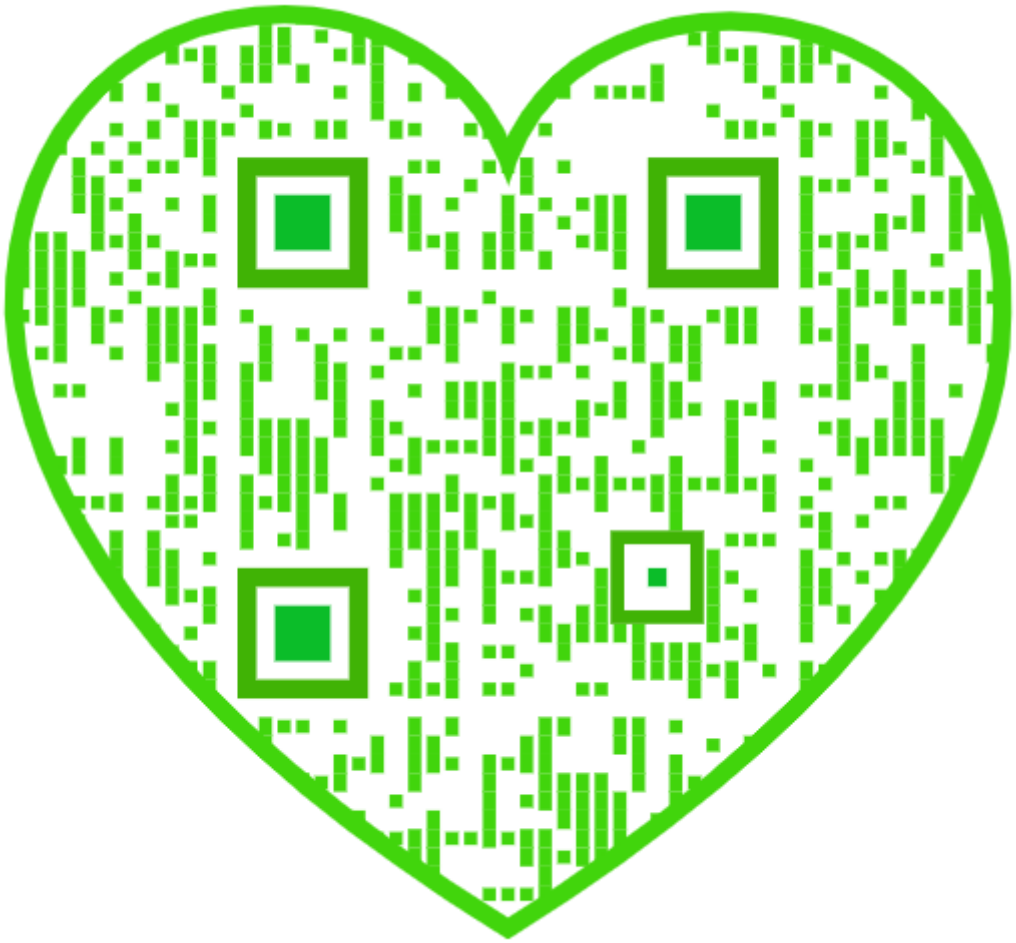
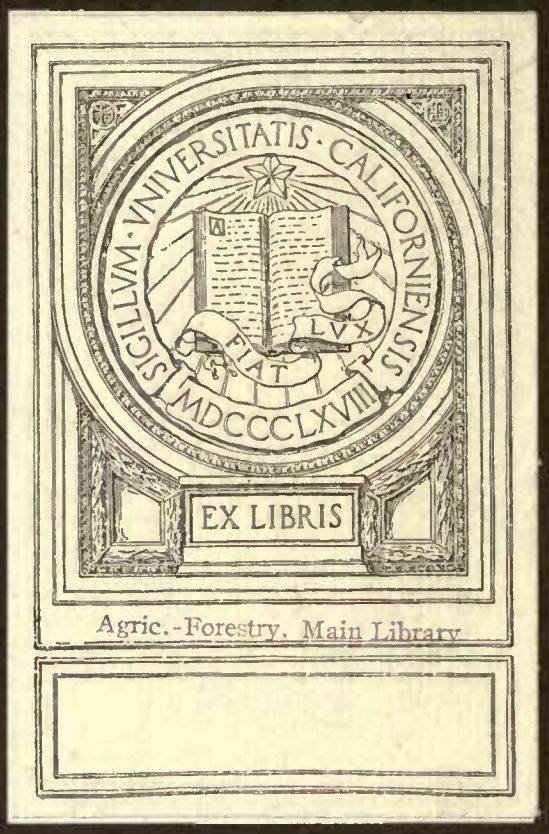
DISCOVERING NEW FACTS ABOUT PAPER





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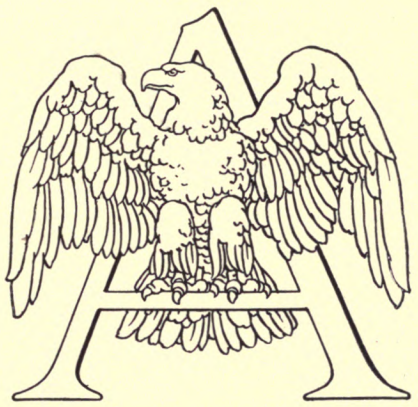
DISCOVERING
NEW FACTS ABOUT PAPER

THIS IS THE FIRST OF A SERIES OF BOOKS TO BE ISSUED BY THE AMERICAN WRITING PAPER COMPANY ON THE SCIENTIFIC STUDIES AND INVESTIGATIONS OF THE DEPARTMENT OF TECHNICAL CONTROL. EVEN WHILE THIS VOLUME WAS IN PREPARATION FOR THE PRESS OLD PROBLEMS THAT HAD LONG BAFFLED THE PAPER-MAKER WERE SOLVED, NEW PROBLEMS WERE PRESENTED FOR SOLUTION, NEW DISCOVERIES OF VAST IMPORTANCE WERE MADE, AND NEW PROCESSES WERE INTRODUCED INTO THE MILLS. SO RAPID AND CONTINUOUS IS THE PROGRESS MADE BY THE RESEARCH AND DEVELOPMENT DIVISION THAT ONLY BY THE PUBLICATION OF BOOKS SUCH AS THIS, FROM TIME TO TIME, CAN THE DEVELOPMENTS BE ANNOUNCED.

DISCOVERING NEW FACTS ABOUT PAPER

The Story of the
Greatest Paper Research Laboratory

By WALDEMAR KAEMPFFERT *Illustrated by* VERNON HOWE BAILEY



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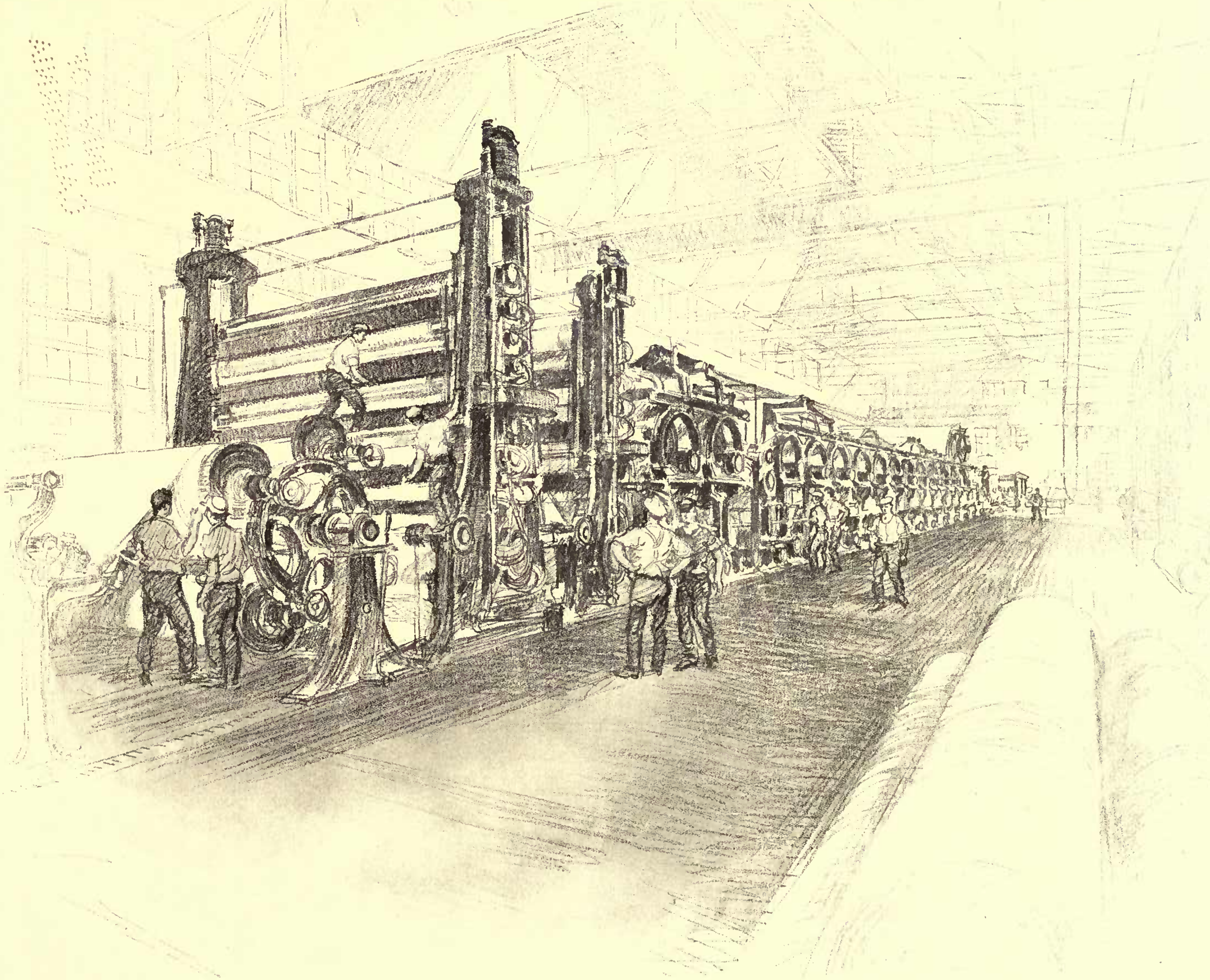


THIS HUGE MACHINE IS THE AMERICAN WRITING PAPER COMPANY'S "SUPER-BOOK." IT IS 262 FEET LONG, AND MAKES A SHEET OF PAPER 12 FEET WIDE AT THE RATE OF 400 FEET A MINUTE

DISCOVERING NEW FACTS ABOUT PAPER

The Story of the
Greatest Paper Research Laboratory

A ROSE is judged by the eye. A better instrument for gauging the comparative beauty of two roses could hardly be desired. Roses are grown and bought to please the eye. To test a rose, look at it. Your only other consideration is that of price. Its price is the measure of a rose's rarity or desirability.

A sheet of paper is a highly complex manufactured product. The man who produced it knows something about the substances from which it was made and the processes that were employed to give it the proper texture, strength, and color; and his knowledge, it may be said in passing, is by no means as complete as it should be. What of the man who buys a sheet of paper? By what standards does he estimate its fitness for the purpose that he has in mind? If he is a paper merchant, he may possibly make a few simple tests for strength. He will probably hold a sample sheet against the light to discover what he can about its formation. He will feel it, tear it, even touch it to his tongue. But the factors that will probably govern his estimate will be price and the reputation of the paper manufacturer. The grocer who needs paper for wrapping, the business man who uses paper for his correspondence and for his records, or the lawyer who sets down on legal cap the terms of a contract or a deed to last a hundred years — what are his standards? Appearance and price — no others. He buys a piece of paper very much as he buys a rose. "That looks good," he says to himself, "and it seems reasonable in price." If he is the kind of man who turns up a box of strawberries in order to make sure that he has not been deceived by a seductively perfect top layer, he may crumple up the sheet of paper or tear it. But in the end he will decide in accordance with his eye and his pocketbook — rose standards.

Now a sheet of paper is in its way just as important to a banker or a lawyer or a business man as a rod of steel to an automobile maker. Suppose the automobile maker were to buy steel as he buys roses. There would be no brake-rods that could be worked several hundred thousand times without snapping, no axles strong enough to support an eighty-ton locomotive, no gears glass-hard on the surface and soft at the core, no spring suspensions that could be flexed a million times without breaking, no valve stems that could be stretched out in special machines without rupturing — in a word, no automobile capable of covering a distance equivalent to the circumference of the earth before extensive repairs are necessary.

The automobile maker sets up standards. He knows exactly what must be the characteristics of the metal out of which engines, shafts, frames, bolts, and nuts must be made. What is more, he

SOLVING THE SIZE PROBLEM

Paper makers speak of "engine sizing," and "tub" or "surface sizing." By engine-sized paper, they mean a paper which has been sized in the beater. Tub or surface-sized paper is made on the Fourdrinier machine, the web moving through a bath of glue or starch or a combination of both. Paper makers were never agreed on the subject of sizing, particularly rosin sizing. Alum and rosin are also two important sizing agents. Either used alone is not very effective, but together they form a compound which waterproofs the fibers and therefore prevents ink from being absorbed and spreading on the writing paper. This subject of sizing has engaged the chemists of the American Writing Paper Company for over ten years. It used to be the practice in most writing-paper mills to use liberal doses of alum whenever the pulp seemed not to be running correctly. Research showed that the practice was to be condemned and that far too much alum is used in indiscriminate ways. During the past three years the American Writing Paper Company has saved $300,000 worth of alum.

Emulsions of rosin and soap are widely used in sizing paper. The best sizing effect is obtained with much free rosin; but emulsions are not easily formed when the free rosin is high. Research conducted in the American Writing Paper Company's laboratory resulted in the development of a process of making a clear rosin size — a solution which will not "settle out" and which has greater sizing power than the ordinary milky emulsions. All the guessing that attended the making of rosin size has disappeared, and an error is corrected by mere inspection. In rosin alone this represents a saving of over $150,000 a year.

tests the steel that he buys, in order to make sure that it meets his standards. If the automobile has ceased to be the butt of comic weeklies, it is solely because price and eye as measuring devices have given place to machines that pull, twist, and bend samples of metal.

There are at least two hundred and fifty major classes of paper, and in each of these classes dozens of varieties are to be found. Writing papers, printing papers, cigarette papers, blotting papers, wrapping papers, corrugated papers, crêpe papers, waterproof papers, cartridge papers, wall papers — the list is endless. A few grades of manuscript and printing paper were made by the mills of Spain, Italy, Germany, France, and England in the twelfth and thirteenth centuries. If we needed any evidence of the advance of civilization, surely we would find it in the bewildering varieties of papers that are now made. Paper has become a necessity. The lithographer demands a paper that will not stretch, the cigarette maker a paper that is free from pinholes and that has certain burning properties, the banker a stock certificate paper of great durability. Every industry uses paper of some kind. It does not specify scientifically what it wants. It says in effect: "Give me a paper on which I can have labels printed, or in which I can wrap cheese, or in which I can pack meat, or which I can use for a cap lining, or which will filter liquids in the laboratory." And the paper maker proceeds to meet these demands. Under the stress of competition in price one paper mill seeks to obtain an advantage by the use of cheaper materials or by modifications in the manufacturing process — devices that are not betrayed in the finished sheet. No wonder the number of papers made to meet a particular requirement is endless.

Clearly the paper trade lacks standards. The

HOW MUCH DIRT IS IN THAT LOT OF PULP?

The American Writing Paper Company buys not merely rags or wood pulp to be converted into paper, but cellulose. In other words, it inspects the raw material. Wood pulp frequently contains dirt. Dirty wood pulp means a dirty sheet of paper. This operator is determining the dirt in a sample of pulp. If some particular lot of pulp is too dirty, he will reject it entirely. The test is made by simply placing the sample sheet over an electric light. The dirt specks are clearly silhouetted. By testing wood pulp for dirt, the laboratory of the American Writing Paper Company has saved as much as $300 per car.

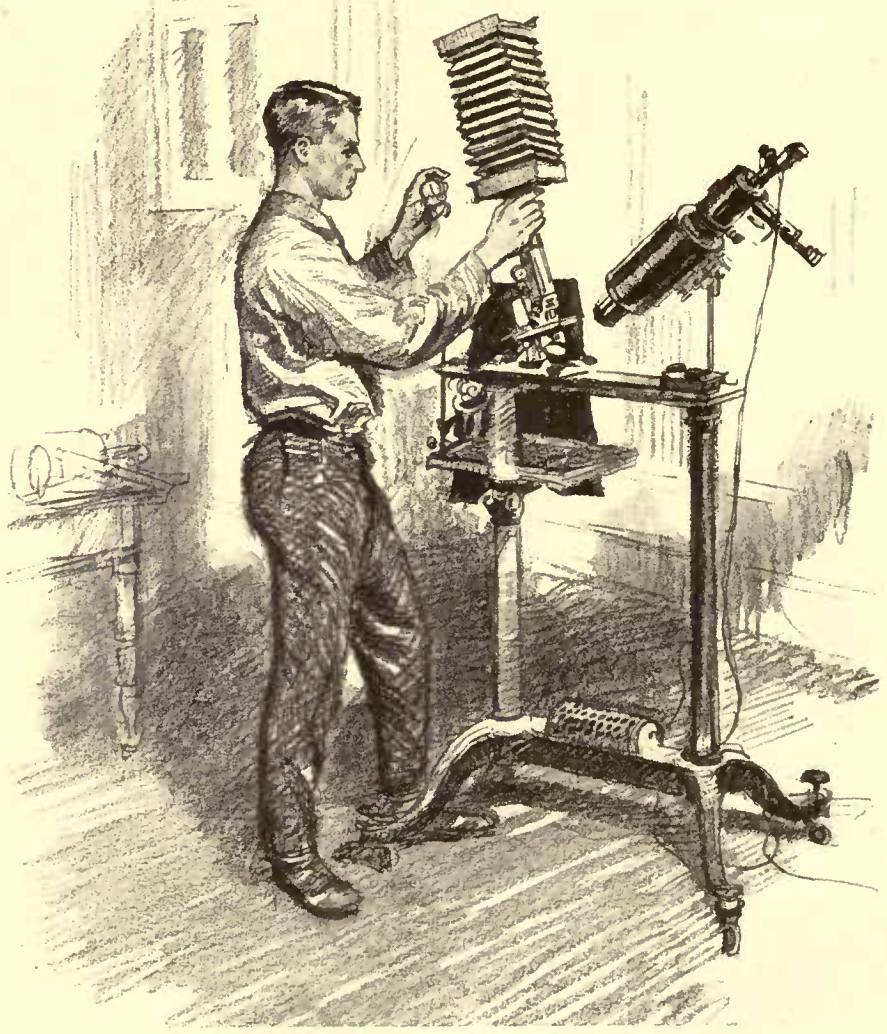
paper maker tells the ultimate consumer very little about the suitability of a given paper for a given purpose. Price dominates the mind of the purchaser — not quality and performance. Pig iron, lumber, explosives, engines, electric lamps, kodaks, are sold according to their ability to fulfill definite purposes; they meet certain standards. But not paper.

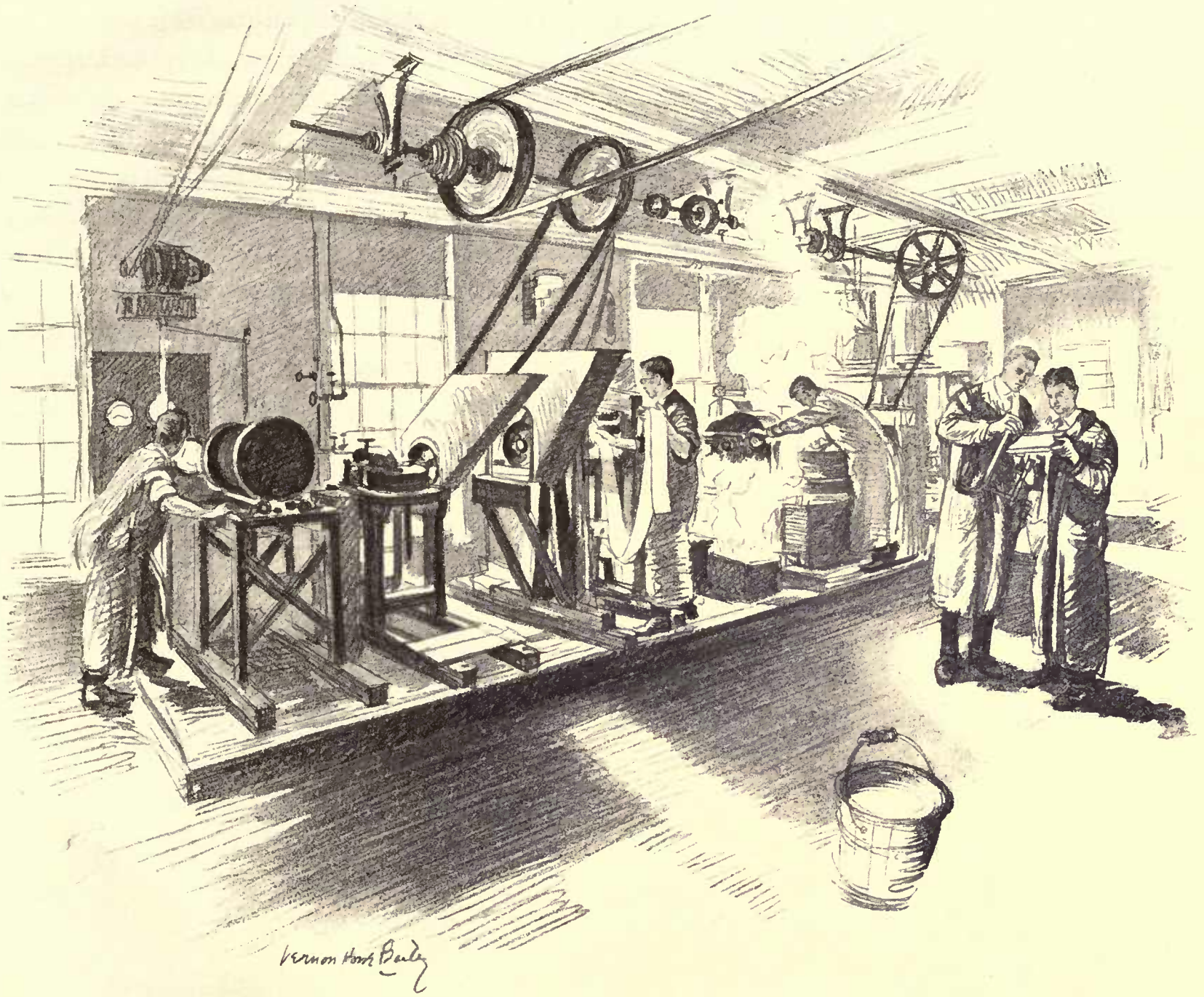
If a manufacturer wishes to standardize his product, he must first know exactly how it is made. This is not intended to be a paradox. Until comparatively recently, the canner did not know exactly what happened when he canned food—evidenced by the fact that a few parts per million of copper rubbed from cooking utensils turn canned corn gray or canned shrimp black, and that string beans not properly blanched are tough and slimy when canned. The glass maker likewise proved that he knew little about his own manufacturing processes when the chemist stepped in and showed him how to make glass, not with twenty different compounds, but with four. To set a standard in an industry, to know exactly what happens when materials are subjected to manufacturing processes, to test a finished product for quality — all this means research.

Now the paper industry has never set up standards for its finished product — standards which will enable the paper merchant or the printer or the ultimate consumer to determine the fitness of a given piece of paper for a particular purpose—because it has never conducted research systematically and thoroughly. Modern pulp-making methods, it is true, have been developed largely by chemical research, but re-

SUBSTITUTING A CAMERA FOR THE EYE

A photograph of what appears on the microscope slide teaches much. The wood out of which a pulp was made can be identified; the degree to which pulp has been bleached can be determined; the pulp produced under different mechanical and cooking conditions can be studied. The average fiber lengths and the percentage of various fibers mixed in a given sample of pulp can be ascertained; the nature and the amount of treatment of the stock received in the beater are revealed. There is hardly a process in paper making that cannot be scientifically studied with the help of microphotographs.





EXPERIMENTING WITH NEW PROCESSES AND NEW PAPER

The mill is not ordinarily the place to carry out a new idea which involves radical changes in manufacturing methods. Indeed, the procedure may prove to be ruinously expensive. The mortality of new ideas is notoriously high. Before the American Writing Paper Company adopts a new idea, the Department of Technical Control is consulted. In that Department a promising material or method is passed through four stages before it is approved or disapproved. In the first stage small laboratory apparatus is used; in the last a full-sized equipment. So, pulp is experimentally made in beaters that range in capacity from one-half to seven hundred and fifty pounds; and paper is made by hand and by a machine which will produce a sheet from twenty to sixty inches wide. Not until the process has successfully passed the fourth stage with beaters of commercial size and with the full width of the paper machine, is the Department of Technical Control convinced.

In this picture the second stage in the making of a new or improved paper is shown. Small hand sheets are produced with the aid of the miniature paper mill with its digesters, washers, beaters, and vats, each doing its allotted part of the work under the most careful scientific observation. The next step to the larger machines can now be taken with much of the uncertainty removed. Thus, guessing gives place to exact knowledge of what a new process or machine will do when introduced in the mill.

search spasmodically conducted. Laboratories are to be found in a few paper mills, and in these some notable improvements in testing methods and in manufacturing processes have been developed. But the conversion of cellulose into paper has never been systematically studied as a whole, year in and year out, as electric illumination, photography, steel, artificial leather, cottonseed oil, and coal-tar dyes have been studied.

It is to this task that the American Writing Paper Company has addressed itself. At Holyoke, Massachusetts, the world's paper city, it has established a department of technical control, a laboratory which explores the unknown in the chemistry of paper. It is a laboratory which is second to none in its high ideals, its personnel, and its equipment.

If paper which is to be used for printing, writing, wrapping, filtering, and thousands of other purposes is to be made of unvarying quality, the first requisite is unvarying raw material. "It can't be done," says the practical paper maker. Wood pulp, rags, cotton, jute, esparto grass—these are the raw materials of the paper industry. No two trees are alike; therefore no two purchases of wood pulp can be alike. No two carloads of rags can possibly be alike. It seems as if any attempt to standardize the making of paper is thwarted at the very outset. But the scientific purchase of raw material is one of the simplest tasks that the laboratory at Holyoke performs. The paper mill wants cellulose—the fiber of which all vegetation is built up. So, the laboratory helps the mill to buy not wood pulp,

MEASURING OPACITY AND COLOR

The transparency of a paper is influenced by the kind of pulp used, the manner in which the pulp has been treated in the beater, the amount and kind of mineral added as a filler, and the bulk of the finished sheet. But how can you tell accurately if one sheet of paper of a certain weight is more or less transparent than another sheet of the same weight? The answer is supplied by an instrument which measures the amount of light that passes through a sample of paper.

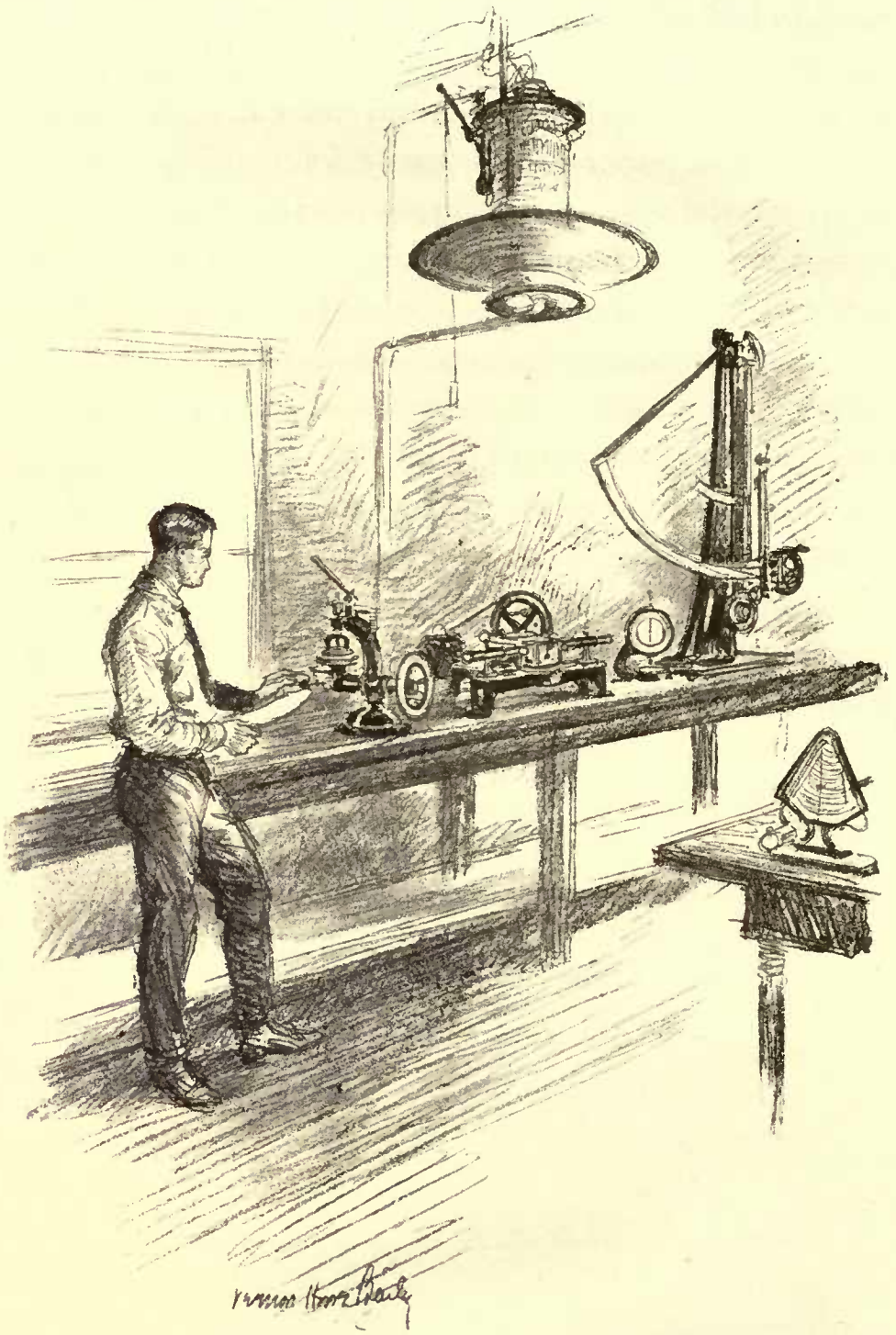
not rags, but cellulose. Similarly, the laboratory sets up standards not for the purchase of *coal*, but *heat*. The laboratory is able to state exactly what kind of paper can be made from a shipment of wood pulp or rags. It studies the fibers. It matters much if they are long or short; for length of fiber determines some of the characteristics of the finished sheet. The natural stiffness of the fibers, too, must be considered. The practical paper maker is guided solely by sight and touch in these matters; the chemists in the laboratory at Holyoke, by the microscopic and chemical findings. Dirty wood pulp may be rejected entirely; it means a dirty sheet of paper. By a scientific examination of the material that comes to the American Writing Paper Company's mills, the laboratory is able to classify its cellulose content and to determine the paper-making value of that cellulose content. As much as $300 a car has been saved by buying not merely wood pulp or rags, but cellulose.

And so it is with the various chemicals that are added at different stages of the manufacturing process to give desired qualities to the finished paper—the dyes, the sizing, the acids and alkalis, the clay, kaolin, and sulphate of lime. The laboratory knows exactly what is to be expected of a given alkali, acid dye, or filler, before it is purchased.

Every step of the paper-making process is similarly controlled. The whole art of paper-making resolves itself into two main processes. Of these the one is a reduction of the cellulose to a pure white pulp, and the second the conversion of the pulp into an entirely new fabric

IT HAS ALL THE QUALITY OF SUNLIGHT

It used to be hard for a paper maker to match the samples for color after four o'clock in the afternoon. Artificial light has not the same color values as sunlight. A glass for an electric lamp has been invented which makes it possible to match at night time. It is used in the laboratory of the American Writing Paper Company.



WHERE THE LABORATORY CONDUCTS PHYSICAL TESTS OF PAPER

If you want to find out in a crude way what is the strength of a rubber band, you stretch it to the limit with your two hands. Similarly the tensile strength of paper is determined, but by a machine (the one in the picture which resembles the sector of a circle). The laboratory operator reads off on the scale what force is required to break the sample in the machine, just as you read off on the dial of a platform scale how heavy you are. There are other machines on the table. One of them folds a paper back and forth hundreds and even thousands of times until it breaks. The number of folds is of course registered automatically. Then there is a gauge which measures thickness, and also a Mullen tester which measures the bursting strength of a piece of paper.

You know that moist paper is not nearly so strong as dry paper. Since moisture tends to weaken, it follows that physical tests of paper must be conducted in a room the atmosphere of which is not dry today and moist tomorrow. The humidity of this testing room is controlled by a special apparatus. That is why it is called "the constant humidity room." Paper sometimes shrinks while it is being transported great distances by rail. Isn't it evident that the atmospheric conditions under which it is made, sold, and used should be standardized?

—a sheet of paper which has the proper surface, thickness, weight, tensile strength, resistance to wear and tear, color, and other attributes.

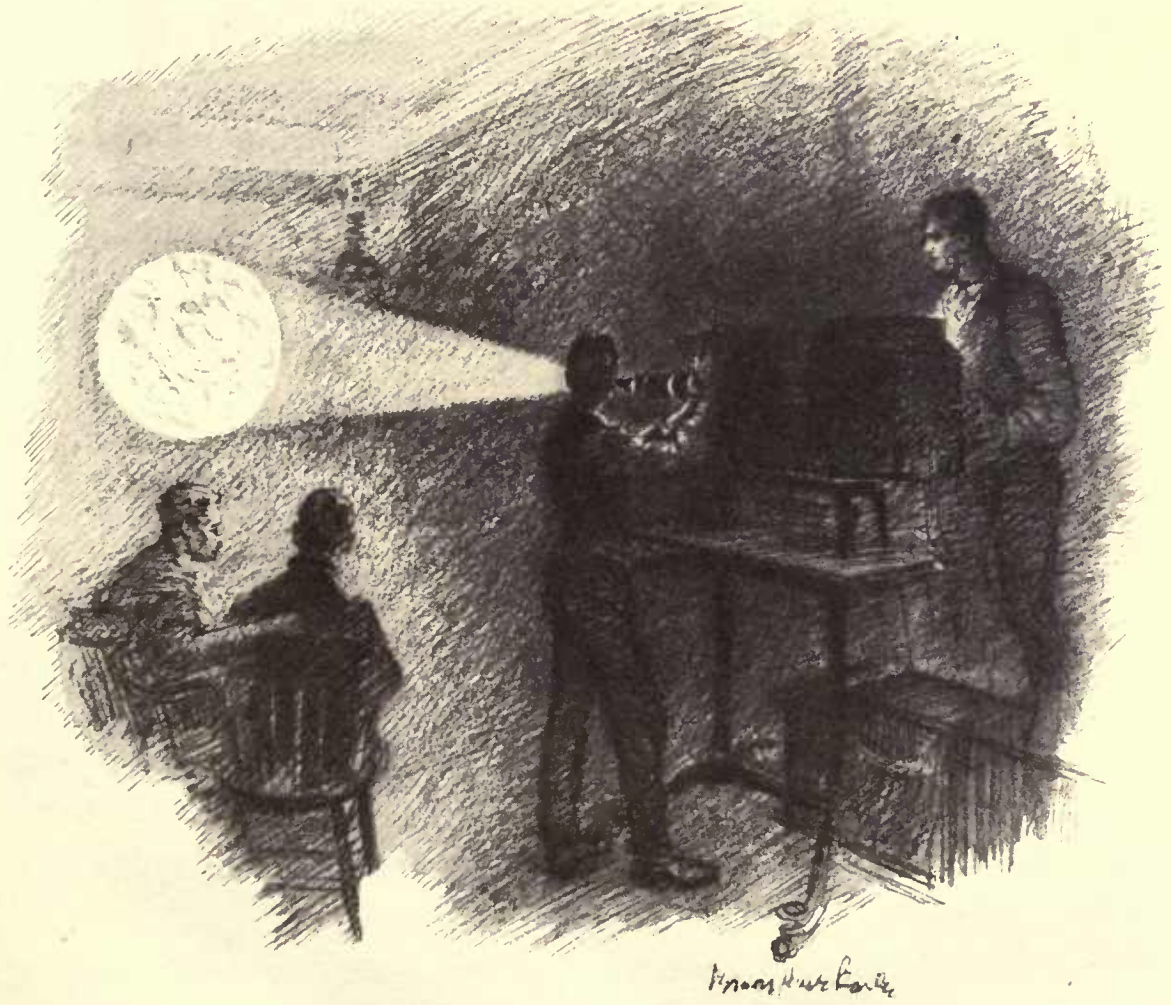
In most paper mills the practical men in charge of operations, men who have learned how to make paper after long experience, are left largely to their own devices. Chemicals are used with little real knowledge of their effect. Wastes result that total several hundred thousand dollars a year in a large mill. It is this very empirical, wasteful method of manufacturing that has made it so difficult to standardize paper products. In the mills of the American Writing Paper Company it has given place to scientific control by the laboratory. The chemists and physicists of the laboratory know exactly what happens when a given chemical is employed—they know because it has been demonstrated in the laboratory. They give precise instructions; they determine all the conditions that shall prevail; they give scientific guidance.

Thus the laboratory at Holyoke has discovered that far too much alum is used in most paper mills. No scientific standards for the use of

alum had been set up; merely the conventions and traditions of paper making governed the use of alum. In the twenty-six mills of the American Writing Paper Company, one hundred thousand dollars are saved every year in alum alone by the adoption of laboratory methods.

Water is a controversial question among paper makers. Hundreds of thousands of gallons are utilized in a day by a single large paper mill. Paper makers know that very hard water introduces difficulties. On the other hand, the laboratory of the American Writing Paper Company has shown that an absolutely soft water is almost equally undesirable. A hundred conditions must be considered in the making of paper. The pulp may be merely pure cellulose or slightly contaminated with unremoved impurities. Sometimes water is charged with bacteria, which manifest their presence by the gelatinous gray slime that they produce, a slime which collects dirt, decomposes the fibers caught in it, leaves a dirty spot in the web, and sometimes breaks off so that a hole is produced in the web. The water may be charged with iron or free from iron, high or low in lime and magnesia; the sizing may vary in alkalinity and composition; some dyestuffs may react differently from others, and some may be readily absorbed while others are resistant. These are scientific questions that can be accurately answered only by a scientifically trained staff.

Take the matter of sizing, for example. It typifies the work which the laboratory at Holyoke is doing. A paper fit to be written upon must be sized so that the ink will not "run." Without sizing it would act like so much blotting paper. On the subject of sizing, as a whole, no two paper makers agree—evidence enough that the



WHAT THE SCREEN SHOWS

Microphotographic slides of fibrous materials, finished papers, samples from the beater, are thrown on the screen in a way made familiar by the stereopticon. Magnified several hundred times or more the characteristics of the specimen under examination become apparent as well as the results of different beating methods.

HOLYOKE
the World's Paper City

laboratory must step in and substitute scientific fact for opinion. This subject of sizing has engaged the chemists of the American Writing Paper Company for over ten years. Soap emulsions of rosin are widely used in sizing paper. The best effect is obtained with much free rosin; but emulsions are not easily formed when the free rosin is high. Research conducted in the laboratory showed that most patented processes for overcoming the difficulty are scientifically wrong, and that emulsions of the worst type are advocated. Finally a process of making a clear rosin size was developed—a solution that will not "settle out" and which has greater sizing power than the ordinary milky emulsion. All the guessing that attended the making and using of rosin size has disappeared. An error is easily corrected by mere inspection. No special machinery is required. In rosin alone a saving of over one hundred thousand dollars a year has been shown to be possible. What the value of the increase in the quality of paper may be cannot be estimated.

It must not be supposed that the experienced mill man is ignored or that he is reduced to a mere automaton who moves in a certain way when the director of the laboratory presses a button. The accumulated experience of decades is not to be thrown on the scrap heap. No sensible laboratory director ignores the advice of a practical paper maker, and the director of the Holyoke laboratory is no exception to this rule. He is guided by the counsel of practical men, especially when it saves him much experimenting. In a sense, the entire manufacturing organization of the American Writing Paper

ESTIMATING THE FIBER CONTENT OF PAPER

First of all he cooked a sample of the paper in a little caustic soda to remove sizing or other binding material. Then he washed the sample and rolled it into a little pill, placed it in a test tube with water, and shook it thoroughly to defiber the particles. He picked out a little of this defibered mass with the aid of a needle, dried it on absorbent paper, and placed it on a microscope slide to be studied as you now see. Microscopic tests of this kind are conducted by the laboratory in order to match paper for customers, as well as to standardize and classify papers.

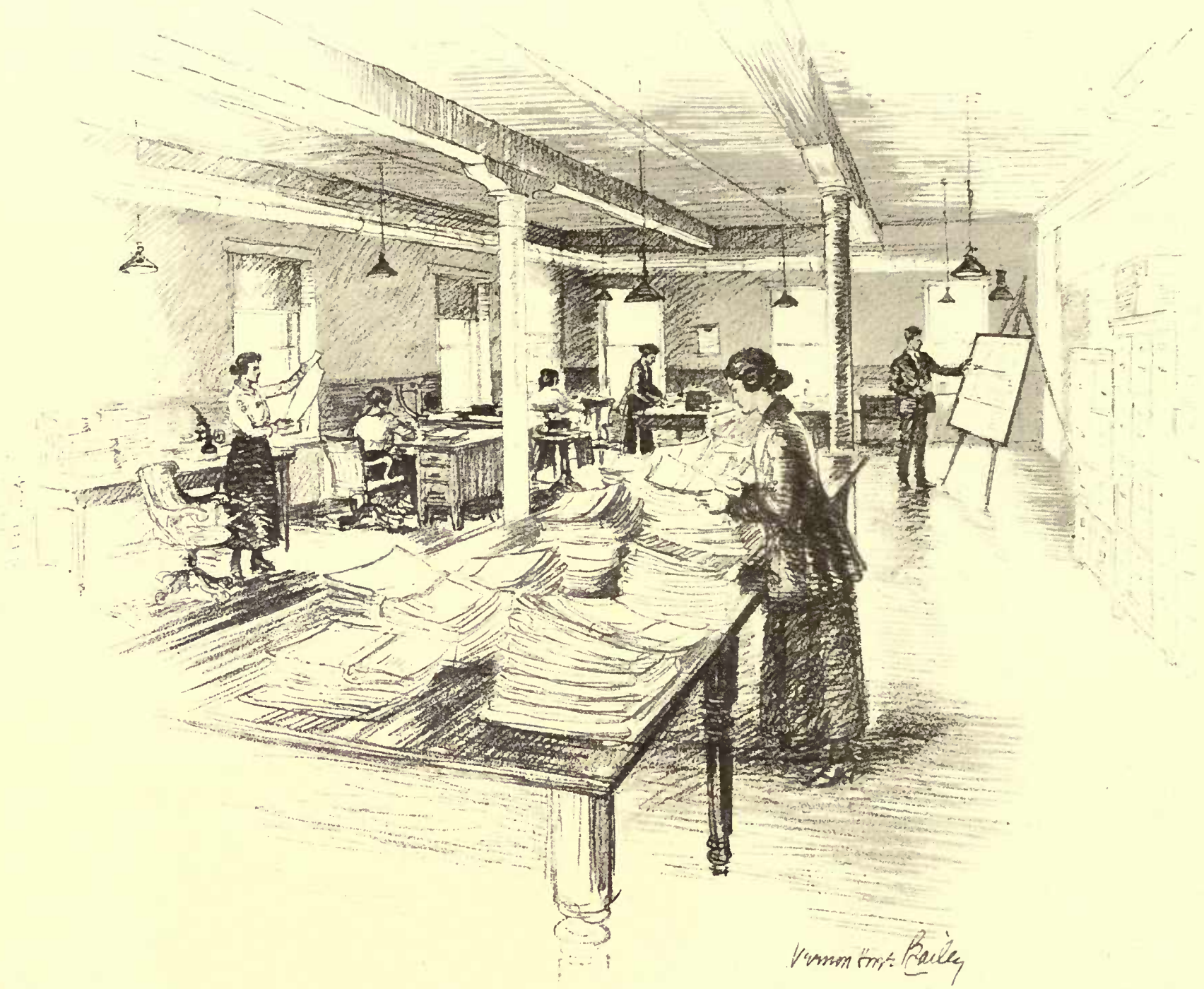
DETERMINING THE FINISH OF PAPER

How smooth is it? What is the finish? The printer always asks these questions about a paper. Printing quality depends in large part on the smoothness and finish of the paper. But how can you predict what the performance of a given sheet of paper will be in the printing shop without actually running it through the press? The eye and the sense of touch are not accurate, scientific gauges. So, in the mills of the American Writing Paper Company this scientific instrument is used to determine exactly the proper finish for a given purpose. Thus it becomes possible to compare the paper produced in a mill with the standard adopted.

Company's twenty-six mills is part of the laboratory personnel. The truth-seeking spirit of science pervades everywhere.

Although the research laboratory is primarily intended to improve the American Writing Paper Company's methods and products, it is more than a commercial institution. The great coal-tar laboratories in Europe conduct research in organic chemistry without any financial goal in view. In the laboratories of a great American electric manufacturing company, an immense amount of purely scientific work was carried on, which, in the beginning, shed more light on the constitution of matter than on the best method of making an incandescent lamp. The greatest camera-making company has a laboratory in which probably more investigations in pure optics are made than in any university in the world. So, the laboratory of the American Writing Paper Company conducts research which is directed to pure theory. A study of the paper industry's problems alone cannot result in any startling advance in paper-making methods — merely in greater manufacturing precision and in the improvement of established processes. But once the fundamental chemistry and physics of cellulose are attacked, regardless of immediate commercial results, discoveries of revolutionary importance must inevitably be made.

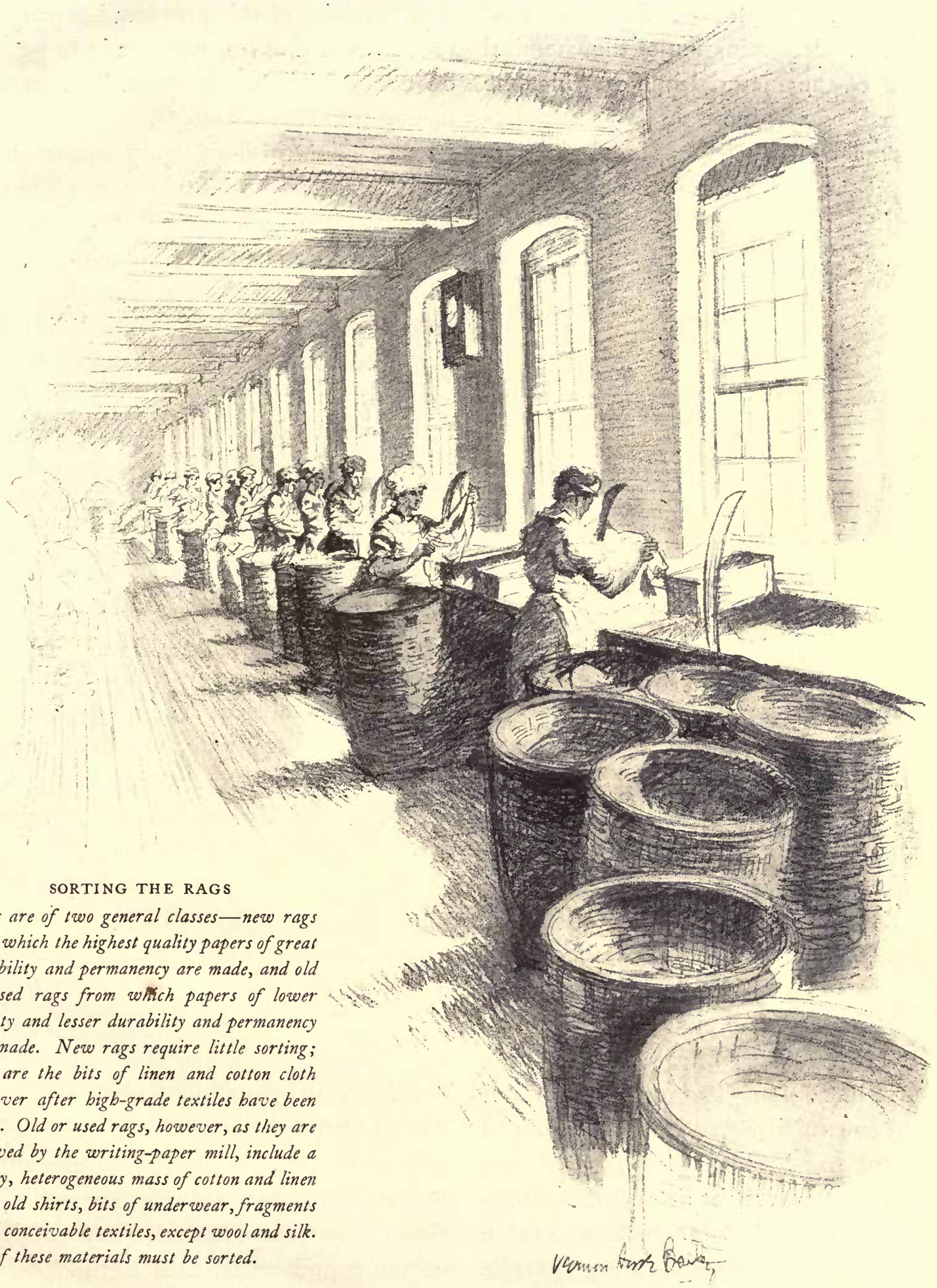
This has been the history of most industrial



WHERE PAPER IS STANDARDIZED

Which of two samples of paper that look alike and feel alike is the better for a given purpose? To answer the question, standards must be set up. All the papers of the American Writing Paper Company, as well as papers sold in the market by other companies, are tested by the laboratory and classified. The day is at hand when paper will be sold on the strength of a label or a watermark which will express scientifically all the facts that the paper user has a right to know. As it is now, the consumer has no means of determining why two papers of apparently the same quality should differ markedly in price. No one tells him.

research. A study of the residual gases in the tungsten lamp gave the world the half-watt, nitrogen-filled lamp—an end undreamed of when the investigation began. Years spent in determining what is the chemical constitution of rubber have resulted in the discovery of a process for making synthetic rubber (real rubber) in the factory. Fifty years of purely scientific research in coal-tar chemistry have enriched the world with several thousand synthetic dyes, flavoring materials, perfumes, and medicines. So, the laboratory at Holyoke conducts research which may have no immediate commercial value, but which is bound to be of industrial importance sooner or later. Suppose that it should work out a precise chemical formula for cellulose. The paper



SORTING THE RAGS

Rags are of two general classes—new rags from which the highest quality papers of great durability and permanency are made, and old or used rags from which papers of lower quality and lesser durability and permanency are made. New rags require little sorting; they are the bits of linen and cotton cloth left over after high-grade textiles have been made. Old or used rags, however, as they are received by the writing-paper mill, include a motley, heterogeneous mass of cotton and linen rags, old shirts, bits of underwear, fragments of all conceivable textiles, except wool and silk. All of these materials must be sorted.

chemist knows only in a general way the chemical constitution of cellulose. To a practical paper maker the determination of the chemical composition of the material out of which he makes paper is one of those theoretical undertakings that seem utterly without industrial purpose. And yet the more the paper maker knows about cellulose, the more will he know about paper making. Perhaps cellulose will some day be synthetized; in other words, artificially built up out of carbon, oxygen, and hydrogen atoms. The synthesis will probably be of no direct commercial benefit because vegetation is too plentiful and cheap. But it will reveal the true chemical formula, and with that to guide him, the paper chemist will with certainty predict results. He would know more about the possibilities of cellulose reactions — important when it is considered that practically every known reaction of cellulose has become the basis of a valuable industrial process and because the paper maker will at last learn what really occurs when cellulose fibers are dyed. Science is a key that unlocks many doors. One discovery points the way to another. That is why the American Writing Paper Company's laboratory studies fundamentals as well as mere paper-making problems.

The paper-mill superintendent to-day has only his eye to guide him in determining the correct amount of bleach to be used in a given lot of rags or wood pulp. No two pairs of eyes see alike. Even the same pair of eyes will not see alike twice in succession. The result of this lack of technical control is over-bleached pulp, and paper made of over-bleached pulp turns yellow in storage. The Department of Technical Control has worked out a method which will enable the superintendent to determine accurately the correct amount of bleach to use, in order to get the brightest color without overbleaching. This is called the "Bleach Index Method." The solution of this problem has progressed to such a point that it is now ready to be tried out on a large commercial scale, laboratory results having proved satisfactory.

This laboratory, which has been established to introduce precise scientific methods in the mills of the American Writing Paper Company, and which has already done so much to standardize paper-making methods and products, occupies an entire building of its own in Holyoke. It is equipped not merely with the usual apparatus of a chemical and physical testing station, but with real paper-making machinery of its own. It has all the facilities for making paper by hand, by small machines, and by full-sized commercial machines which will produce a continuous web of paper from twenty to sixty inches wide. Whether or not a new paper-making material or a new process has industrial possibilities can hardly be economically determined in the mills. On the other hand, a laboratory success proves little. A new material or a new manufacturing method must pass through four stages in the American Writing Paper Company's laboratory before it is definitely adopted or rejected. The first stage — the laboratory stage — yields the discovery. In the second stage, small hand sheets are made with small apparatus. If the results are satisfactory, the third stage is entered, which means that paper is made by machinery which is an accurate reproduction of that to be found in the mill. Finally, in the fourth stage, paper is made on what is really a commercial scale, but still under laboratory control. The obstacles and the defects that appear at each stage are many. Not until this fourth stage has been successfully passed are the experimental data translated into mill terms. The paper thus made is not a laboratory curiosity. It can be sold — proof of the commer-

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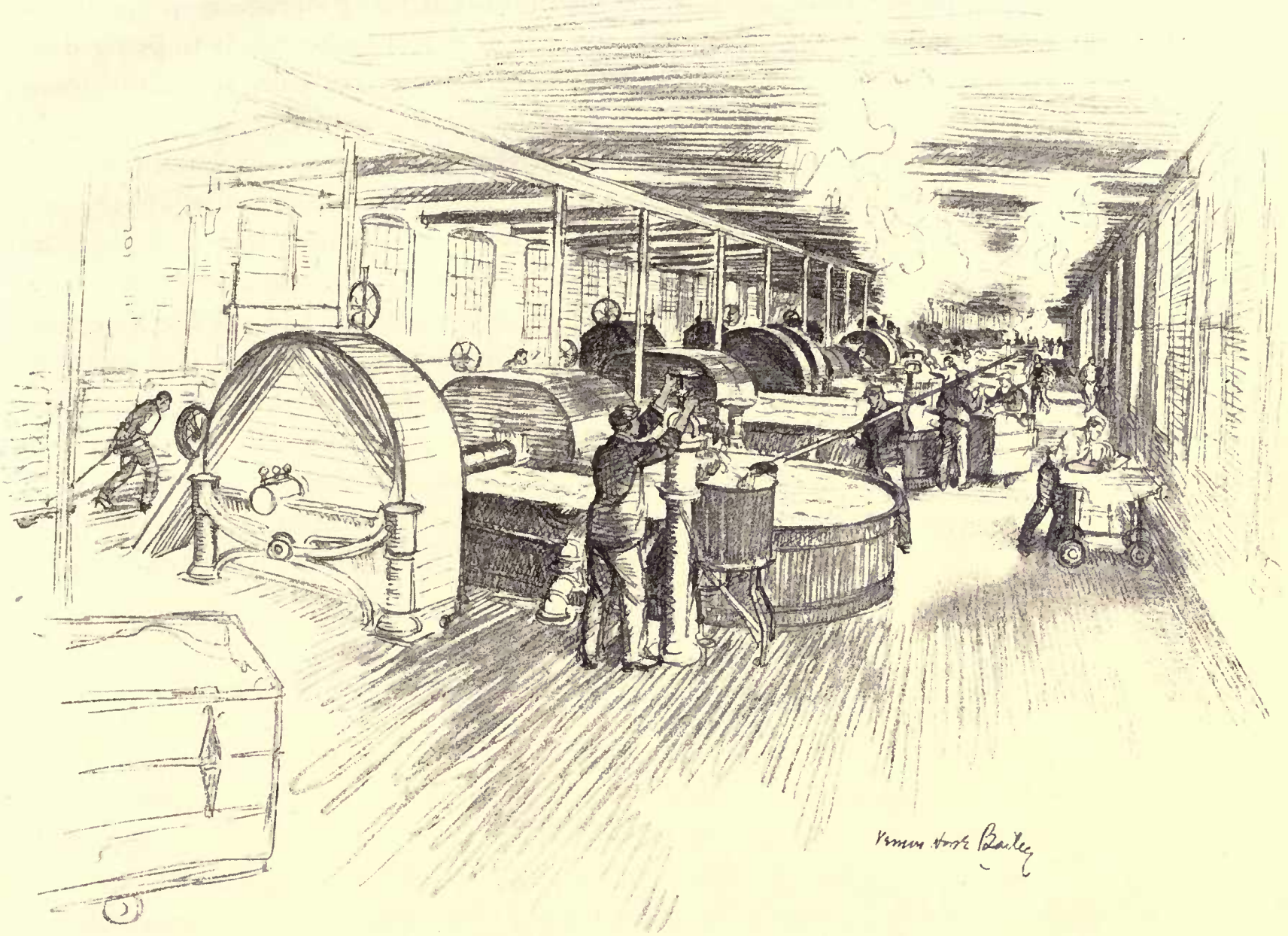
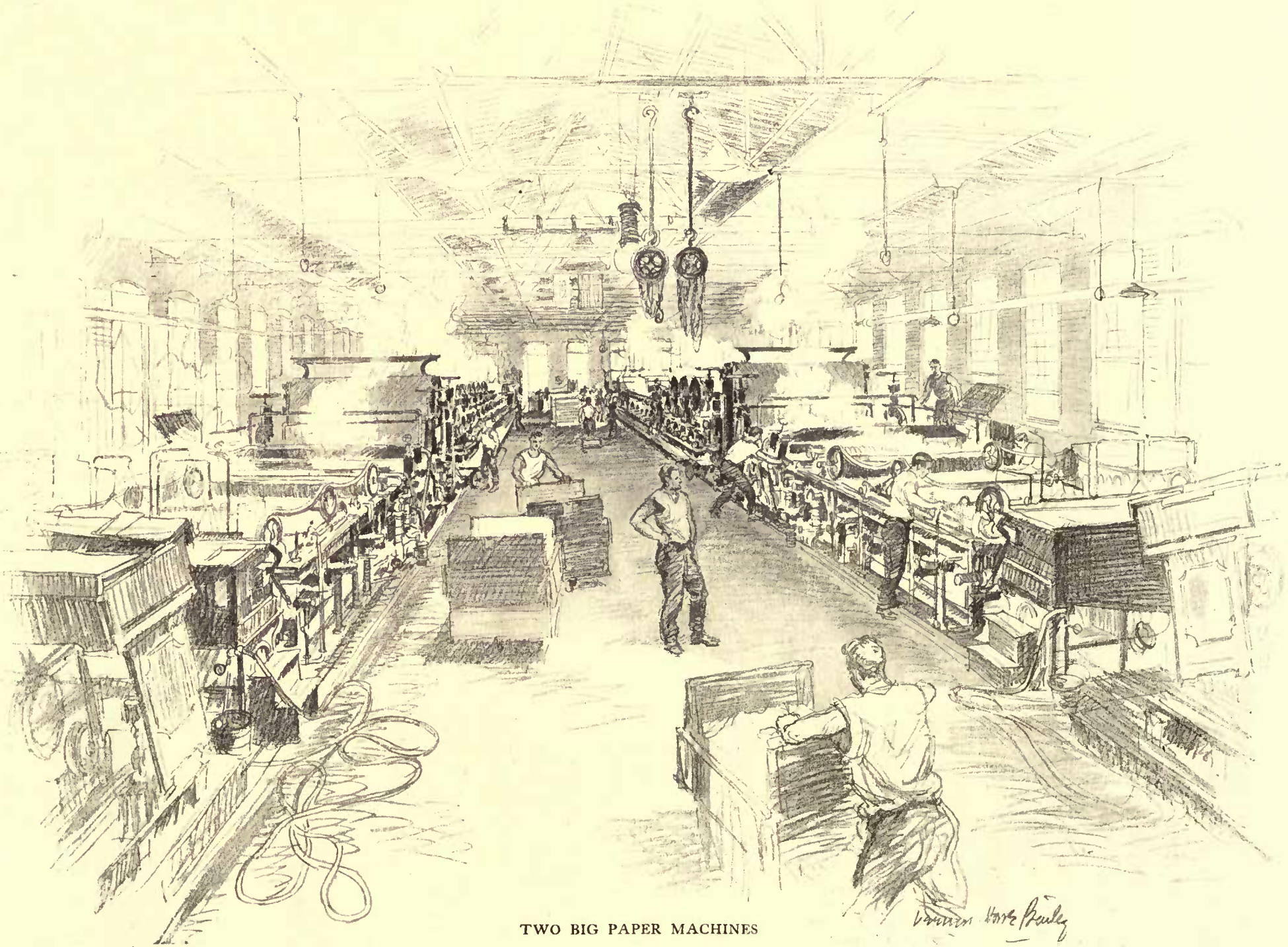


BEATING THE STOCK

Cellulose used to be disintegrated into its individual fibers in a kind of mortar with the aid of a tightly fitting pestle. It was literally beaten. Now the process is mechanically carried out in the "beating engine" or "beater," its very name indicating its relation to the old mortar. The beating engine resembles the washer in construction. An oval trough is partially divided by a wall, or "midfeather," to form two channels. In the bottom of one channel is a bedplate provided with steel knives, and above the bedplate is a heavy roll also provided with steel knives. The action of the co-acting blades of the roll and bedplate is somewhat like that of a pair of scissors. Thus the stock is shredded or teased into its individual fibers. During the process, which is a combination of beating and shearing, various chemicals are added which are to give certain desired qualities to the finished paper. Is the paper to be red, yellow, or blue? The proper coloring matter is added. Is it to be non-absorbent to ink? Some form of animal or vegetable sizing is used. Is the finished paper to be soft-glazed? Loading material (china clay, kaolin, sulphate of lime, or "blanc fixe") is called for. In most mills the beater engineer is left to his own devices in the matter of matching a given sample of paper for finish, formation, color, strength, and wear. But in the American Writing Paper Company's mills the beater man has his "furnish" scientifically laid out for him. The task is standardized.



TWO BIG PAPER MACHINES

In spite of the purely automatic operation of the Fourdrinier machine, the personal equation still plays its part. Research conducted in the American Writing Paper Company's laboratory is now under way to show at what angle the wire screen of the Fourdrinier should be pitched to secure the best results with a given stock, and what is the best position for the suction boxes. The character of the "shake" imparted to the wire is to be studied — both its speed and its length. The rate of drainage, too, needs investigation.

In the Linden Mill of the American Writing Paper Company are two giant Fourdrinier machines. Milky pulp enters at one end of each machine, finished paper is rolled up at the other. Paper is formed by the simple process of draining the pulp as it flows over a wire screen, which is constantly shaken. The web thus formed passes successively between rolls that squeeze out the water and between heated drying-rolls.

cial magnitude on which the investigation was conducted. In a word, the laboratory is completely equipped with beaters and all the machinery necessary for the continuous production of paper at the rate of five hundred pounds an hour. Were it desirable to do so, the machinery could be operated for weeks, producing a finished commercial paper.

That section of the laboratory in which the large paper-making machines are to be found constitutes also a school for the selling force of the American Writing Paper Company. How many paper salesmen have any real, accurate knowledge of paper making—anything but a smattering of paper terminology? Each representative of the American Writing Paper Company must not only watch the making of paper in the mills, but he receives instruction in the laboratory in the science and art of paper making.

The salesman who has a working knowledge of paper-making methods can help a customer to select the right kind of paper for a particular purpose. What is more, he knows what not to promise.

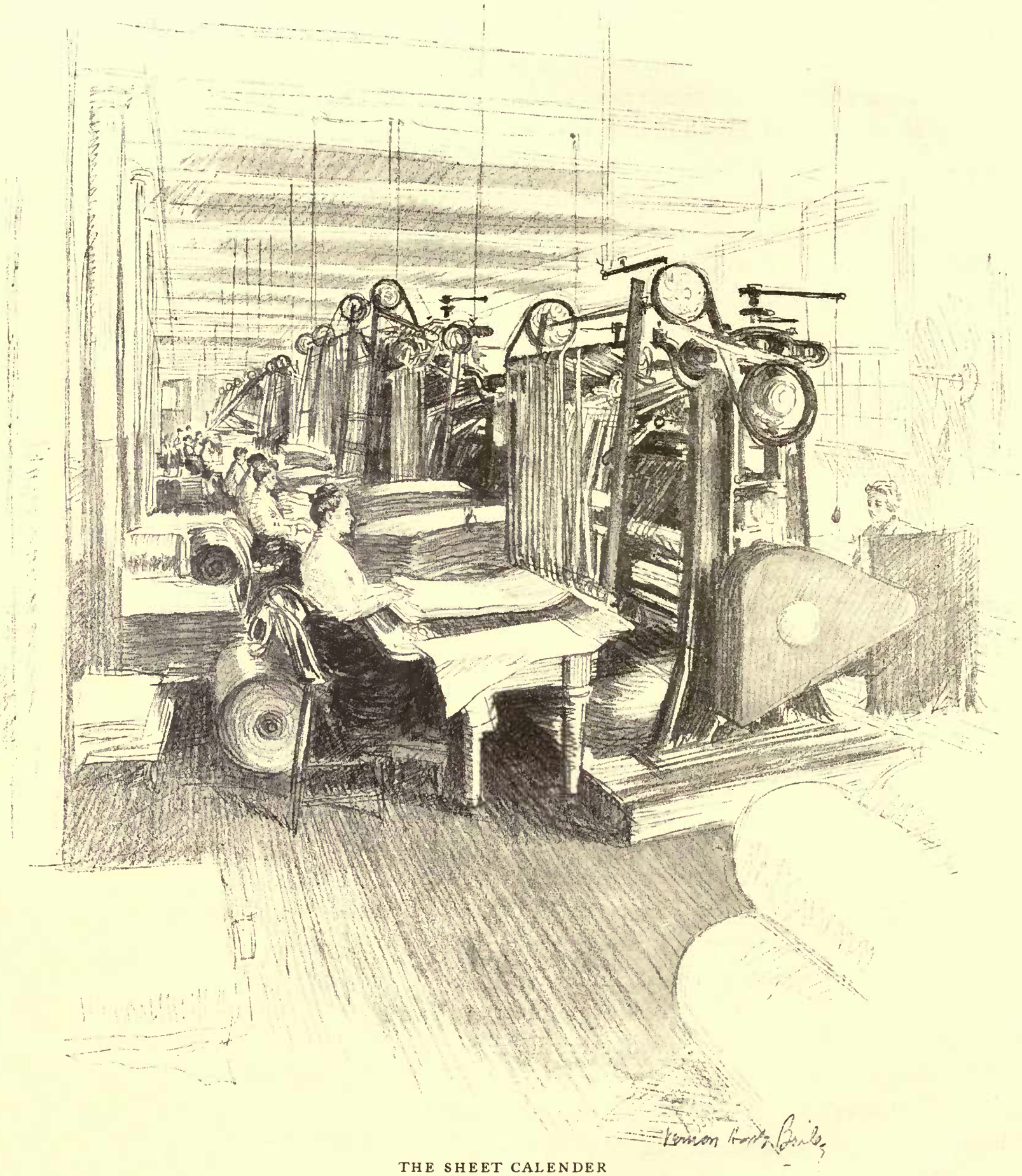
"Can you give me a piece of paper like this at the same price?" the customer invariably asks.

The salesman who knows how paper is made knows that no two trees in the forest grow alike, knows that no two shipments of rags are alike, knows that it will be impossible to start with absolutely equivalent raw materials. But he can say this: "Give me a sample. I will take it to our laboratory for analysis. Tell me what tensile, tearing, or folding tests the paper must withstand, regardless of what this sample may reveal. Tell me how heavy your paper must be. Tell me exactly what you expect of it."

In other words, a salesman of the American Writing Paper Company sells paper according to scientific standards that meet particular uses, and not merely according to weight and price.

To carry out this policy to its logical conclusion, the American Writing Paper Company throws open the doors of its laboratory to the entire paper-making industry. Merchants, perplexed as they are by the claims of rival salesmen and unable to conduct tests of their own sufficiently elaborate, may turn to the laboratory for guidance and advice with the assurance that they will learn the scientific truth. Paper makers may consult the chemists and physicists of the laboratory when their own technical resources are inadequate. Thus, the laboratory was recently called upon to act as a scientific arbiter in a dispute between a competing New England paper mill and a dealer in a necessary loading material; the mill claiming that the material supplied by the dealer set up undesirable acid reactions, the dealer stoutly maintaining the contrary. And what was the result? The company that makes this particular loading material has requested the laboratory to draw up specifications which it will follow in the future—specifications which promise to be adopted by the entire paper industry. Lest those who thus consult the laboratory fear that their processes are not sufficiently safeguarded, specially equipped rooms are provided to which none have access without permission, and which are locked.

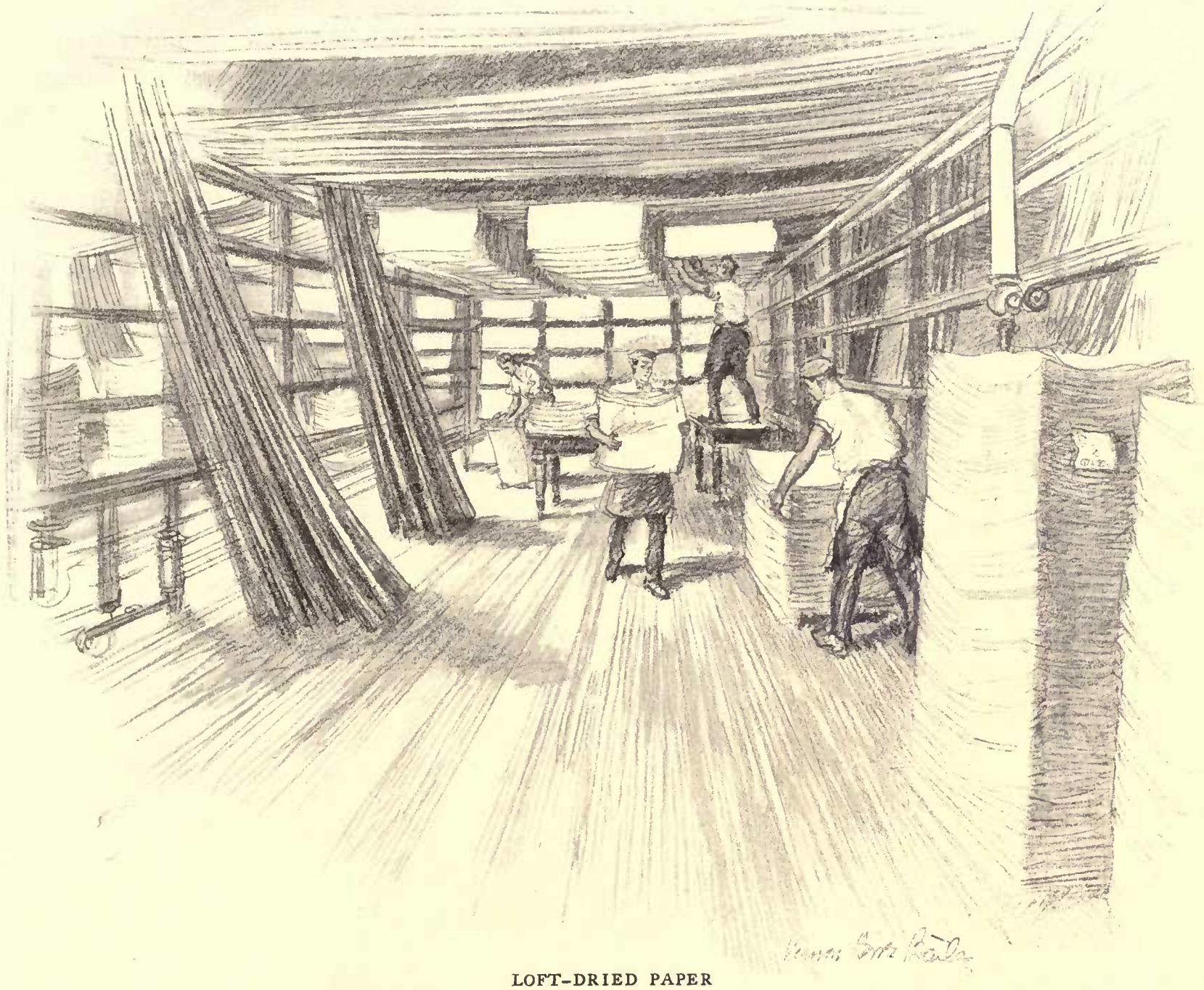
To abolish senseless and wasteful trade practices is one aim of the research laboratory of the American Writing Paper Company. Writing papers have long been sold by the pound. Often special weights are ordered for no particular reason. New weights and sizes are added to already interminable lists. To abolish this vicious system or lack of system, the Writing Paper Manufacturers Association has adopted the principle of selling only by substance numbers. Of the many weights made, certain ones alone are desirable, and only these weights and substances



THE SHEET CALENDER

Here, the rough-dried paper from the lofts is receiving a finish.

The whole question of producing satisfactory finishes is dependent upon drying the paper under controlled humidity. This problem is being studied for the purpose of producing papers of the highest quality.



LOFT-DRIED PAPER

The finest grades of writing paper are "loft dried." After having been wound up on the Fourdrinier machine, the paper is cut into sheets of the proper size and stored in lofts. In a sense, the paper is allowed to season.

are now manufactured by the American Writing Paper Company. Thus a beginning has been made in the standardization of papers, according to definite weights. The paper machine runs at full capacity, with none of the loss of time incurred when adjustments are rendered necessary by odd weights. But much more remains to be done. Thousands of unnecessary papers are still made — not only papers for writing, but papers for every purpose. To eliminate the unnecessary and to classify the necessary is not the least important task of the laboratory. When that task is accomplished, with the aid of the entire writing-paper industry, both the jobber and the consumer will benefit. No longer will the jobber be asked to carry in his stock-room varieties of paper which respond to mere whims. His huge investment in mere paper may be liquidated; his money is released so that it may be applied in expanding his business.

From all this it follows that industrial research of the kind that is conducted at Holyoke, Massachusetts, serves three purposes:

1. It sets up standards for the purchase of material, the control of manufacturing processes, the maintenance of quality in the finished product, and the scientific classification of products.

2. It discovers and develops the possibilities of new materials, new processes, and new products.

3. It carries on investigations in pure science which may have no immediate commercial purpose, but which must ultimately benefit the industry.

It must be evident that, after the research laboratory has instructed the mill how to proceed, the resultant paper product must be different from the product of the mill that buys its raw materials haphazard and exercises no strict control over the manufacturing steps. There is no room for arguing when such a product is offered for sale. Its quality, its properties, its characteristics, have been scientifically determined. Like the electric incandescent lamp, it bears a label which is at once a scientific description and a guarantee that paper made under the control of the research laboratory is a scientific, a standardized product. The manufacturer of that piece of paper knows everything there is to be known about it. Sheer speculation gives place in his case to certainty.

Consequently, research must result in promoting fair dealing in the paper trade. It is an old maxim that the buyer of goods must be on his guard. *Caveat emptor* — let the buyer be-

THE EXHIBIT ROOM

Thousands of papers are made by the American Writing Paper Company. Specimens of all are to be found in this room.

ware! Most trade trickery escapes unpunished because the maxim is an accepted principle of the common law. The burden of informing himself is thrown on the buyer, and yet the buyer is helpless because only the seller is in possession of all the technical facts.

The establishment of a research laboratory implies at least a moral abandonment of the old *caveat emptor* principle. Research means that the manufacturer, the seller, must be on his guard —more than the buyer. He dares to assume obligations. Because he has all the technical facts he knows exactly what he can promise. Are not his products made from tested raw materials, by a scientifically controlled process? Are they not scientifically measured for quality before they are sold?

Permanent success must rest on the "square deal." And the very essence of the "square deal" is industrial research.

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